

Health Consultation

Public Comment Release

Churchill County Tap Water

FALLON LEUKEMIA PROJECT

FALLON, CHURCHILL COUNTY, NEVADA

JULY 18, 2003

Comment Period End Date: August 25, 2003

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

Agency for Toxic Substances and Disease Registry

Division of Health Assessment and Consultation

Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material. In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members.

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1) provide the public, particularly the community associated with a site, the opportunity to comment on the public health findings, 2) evaluate whether the community health concerns have been adequately addressed, and 3) provide ATSDR with additional information. There will be a time period for written comments, which will run until August 25, 2003. Please address correspondence

to the Chief, Program Evaluation, Records, and Information Services Branch, Division of Health Assessment and Consultation, Agency for Toxic Substances and Disease Registry, Fallon Leukemia Project, 1600 Clifton Road, NE (E60), Atlanta, Georgia 30333.

The conclusions and recommendations presented in this health consultation are the result of site specific analyses and are not to be cited or quoted for other evaluations or health consultations.

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HEALTH CONSULTATION

Churchill County Tap Water

FALLON LEUKEMIA PROJECT

FALLON, CHURCHILL COUNTY, NEVADA

Prepared by:

Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Background and Statement of Issues

In July 2000, the Nevada Department of Human Resources, Nevada State Health Division (NSHD), identified an increase in the incidence rate of leukemia in children from Churchill County, Nevada. Most of the leukemia cases were from the city of Fallon, the largest population center in the county. Approximately 7,540 residents live in Fallon and about 24,000 people live in the surrounding unincorporated parts of Churchill County, a 5,000 square-mile area [1].

In March 2001, the NSHD asked the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Center for Environmental Health (NCEH) to evaluate environmental risk factors that might be linked to the childhood leukemia cluster in the Fallon area. NCEH was asked to design and conduct a cross-sectional exposure assessment of selective contaminants using environmental (household) and biologic specimens for case families and for a reference population [2]. ATSDR was asked to evaluate contaminant releases in Churchill County and provide an assessment of completed exposure pathways for the case families.

ATSDR and NCEH developed a Public Health Action Plan that identified the pathways to be evaluated for available sampling data, data gaps, and potential human exposures [3]. These pathways include groundwater, air, soil, surface water, sediment, and biota [3].

This health consultation addresses the potential environmental pathways for human exposure to contaminated drinking water in Churchill County. ATSDR evaluated the available environmental sampling information to determine potential exposure to contaminants found in drinking water. The information reviewed includes data collected by the U.S. Geological Survey (USGS) and Water Research and Development, Inc.

ATSDR's EVALUATION PROCESS

ATSDR's approach to evaluating a potential health concern has two components. The first component involves a screening process that might indicate the need for further analysis. The second component involves a weight-of-evidence approach that integrates estimates of likely exposure with information about the toxicology and epidemiology of the substances of interest.

Screening is a process of comparing appropriate environmental concentrations and doses to ATSDR or U.S. Environmental Protection Agency (EPA) comparison values (CVs). These CVs include:

- ATSDR Environmental Media Evaluation Guides (EMEGs),
- Reference Media Evaluation Guides (RMEGs),
- Minimal Risk Levels (MRLs),
- Cancer Risk Evaluation Guidelines (CREGs),

- EPA Reference Concentrations (RfCs),
- EPA Reference Doses (RfDs), and
- Risk-Based Concentrations (RBCs).

These health-based CVs are media-specific concentrations that are considered “safe” under default conditions of exposure. Default conditions are typically based on estimates of exposure in most (i.e., the 90th percentile or more) of the general population. CVs are not thresholds of toxicity, but levels at which ATSDR believes that even long-term exposure to sensitive populations would not result in an increase in the likelihood of developing adverse health effects. A level above a CV does not mean health effects are expected, but represents a point at which further evaluation is warranted.

CVs are based on a variety of toxicological and exposure assumptions that might not reflect actual exposure conditions and risk of adverse health outcomes. ATSDR evaluates information related to the contaminant and on site-specific exposure conditions. Such information might include biological plausibility, mechanisms of action, cumulative interactions, health outcome data, strength of epidemiologic and animal studies, and toxicologic and pharmacologic characteristics.

Drinking Water Sources in the Fallon Area

In Churchill County, groundwater is the sole source of drinking water [R. Seiler, USGS, personal communication, 2003]. A basalt aquifer and two sedimentary aquifers are used as sources of drinking water. Groundwater from the basalt aquifer is distinctly different from that in the sedimentary aquifers [4]. The basalt aquifer is the source of water for municipal supply to the city of Fallon, Naval Air Station Fallon, and the Fallon Paiute-Shoshone Tribe [4].

The shallow sedimentary aquifer extends from the water table to a depth of 50 feet below land surface [4]. The intermediate sedimentary aquifer is considered to extend from a depth of 50 feet below land surface to between 500 and 1000 feet [4]. A deep sedimentary aquifer, considered non-potable, extends from 500 to 1000 feet below land surface to depths of several thousand feet [4]. The basalt aquifer has been described as an asymmetrical, mushroom-shaped body of basalt exposed at Rattlesnake Hill [4].

Overall, dissolved arsenic concentrations in Churchill County groundwater exceed the maximum contaminant level (MCL) of 10 parts per billion (ppb) promulgated by EPA. The combination of high pH and high arsenic concentrations is characteristic of groundwater in the western United States that also has high arsenic concentrations [5].

Residential Drinking Water Sampling Results

In 2002, the USGS conducted residential tap water sampling as part of NCEH's cross-sectional exposure assessment. USGS personnel collected a tap water sample from each of 77 locations. These locations included 76 case and control residences and one supermarket water dispenser. Tap water in Churchill County is drawn from several well sources. These sources include public water supply wells in the basalt aquifer and private wells drawing water from various depths. In addition, many residents reported using bottled water for drinking [6].

Of the 76 household taps sampled, 42 of them used private wells as a water source and 34 used the public water supply. Sixteen homes used reverse osmosis (RO) water treatment units to remove metals and other contaminants [6]. All tap water samples were analyzed for metals and volatile organic compounds (VOCs) [7].

Discussion

Exposure pathways are the different ways that contaminants move in the environment and the different ways that people can come into contact with these contaminants (i.e., touching, breathing, or eating/drinking them). A completed exposure pathway exists when information shows that people have come into contact with a contaminant in soil, air, or water. Completed exposure pathways can occur in the past or present. The exposure pathways associated with drinking water are ingestion, dermal exposure, and inhalation.

DATA EVALUATION

Metals

ATSDR compared the levels found in residential tap water with health-based CVs to identify potential contaminants of concern (COCs). Several metals were found at levels below the ATSDR drinking water screening values, EPA MCLs, or EPA Region III Risk-Based Concentrations. These metals were barium, beryllium, cadmium, chromium, cobalt, copper, lead, nickel, selenium, silver, thallium, and zinc and were eliminated from consideration.

Antimony, arsenic, tungsten, uranium, and vanadium were also found in residential drinking water (Table 1). Ingestion is the primary route of exposure for metals in drinking water.

Table 1. Summary of Potential Metals of Concern in Tap Water

Substance	Number of Detections	Maximum Concentration (ppb)	Average Detected Concentration (ppb)	Comparison Value (ppb)
Antimony	14	13	3.0	4
Arsenic	77	874	81.7	10*
Tungsten	77	337	19.9	NA
Uranium	74	290	14.1	30*
Vanadium	42	430	45	30

NA means “not available”.

* U.S. EPA Maximum Contaminant Level

Antimony

Antimony was detected in 14 tap water samples at concentrations ranging from 0.9–13 ppb. The highest measured concentration (13 ppb) was found in water collected from a supermarket drinking water dispenser. The highest antimony level found in residential tap water (6.3 ppb) was from a domestic well less than 50 feet deep.

The maximum level exceeds the ATSDR chronic RMEG for children (4 ppb) by a factor of 3.25. However, the RMEG incorporates an uncertainty factor of 1,000 and most people use more than one source of drinking water throughout the day. As a result, even the highest antimony level found is not expected to produce any adverse health effects [8].

Arsenic

Arsenic can be released to water from the natural weathering of soil and rocks and can also leach from soil and minerals into groundwater. In some western states with mineral deposits high in arsenic, groundwater levels of up to 3,400 µg/L arsenic have been found. Most arsenic in natural waters is a mixture of arsenate (trivalent arsenic or AsIII) and arsenite (pentavalent arsenic or AsV), with arsenate (AsIII) usually predominating [10]. Most of the arsenic in the basalt aquifer is present as arsenate (AsIII).

Health risks from exposure to arsenic in groundwater occur as a result of ingestion and not dermal or inhalation exposure. Ingestion of arsenic can increase the risk for skin cancer and internal cancers: liver, lung, bladder, and kidney. The lowest-observable-adverse-effect level for lung cancer in humans is reported as 0.0011 mg/kg/day [15]. Assuming that drinking water is the sole arsenic source for a 70-kg adult, this dose corresponds to 38.5 ppb in drinking water. Arsenic levels in 66 of the 77 tap water samples collected were above the EPA Maximum

Contaminant Level (MCL) for arsenic in drinking water (10 ppb) [9]. The concentrations of total arsenic detected in the tap water samples ranged from 2 to 874 ppb. The highest tap water arsenic level (874 ppb) was from a residential domestic well in the shallow (<50 feet deep) aquifer. The median level of arsenic was 35 ppb in this shallow aquifer. The highest arsenic concentration found in tap water obtained from intermediate-depth wells was 683 ppb (median level 21.5 ppb). The highest arsenic concentration found in tap water from the public drinking water supply was 102 ppb. The median level of arsenic in the public water supply was 90.5 ppb. Of the 72 tap water samples collected from shallow or intermediate-depth wells, five samples showed arsenic levels greater than 200 ppb. These highest results were 245, 257, 463, 683, and 874 ppb.

The arsenic levels in all collected tap water samples exceed the ATSDR EMEG for a child's chronic (long-term) ingestion of arsenic in drinking water. ATSDR based this EMEG on a Taiwanese drinking water study and determined that 0.0008 milligrams per kilogram per day (mg/kg/day) was the highest intake not associated with an adverse noncancerous effect (or no-observed-adverse-effect level [NOAEL]) [10]. Assuming that drinking water is the sole arsenic source for a 70-kg adult, this dose corresponds to 28 ppb in drinking water.

Collectively, however, similar studies in India, Mexico, Chile, and the Western United States indicate that the threshold for hyperkeratosis and hyperpigmentation is approximately 0.01 mg/kg/day or about 700 micrograms of arsenic a day for a 70-kg adult. The estimated intake from drinking the highest total arsenic level found (874 ppb) in Churchill County could exceed 1750 micrograms per day ($\mu\text{g/day}$) based on a consumption of more than 2 liters of water per day.

The effects observed in the Taiwanese drinking water study have never been seen in U.S. populations exposed to 100–200 ppb arsenic [10]. Because of the ordinarily efficient methylation, or detoxification, of ingested arsenic, blood levels of arsenic do not begin to rise until intake exceeds 200–250 $\mu\text{g/day}$ and a person's methylation capacity is reduced [11]. In a Utah study in which a low incidence (<5%) of hyperkeratosis was observed, arsenical hyperkeratosis was dose-related and exhibited a threshold of 350–400 $\mu\text{g/day}$ [12]. In people with adequate methylation capacity, that capacity becomes saturated between 500 and 1000 $\mu\text{g/day}$ [13].

Because of the limitations of studies performed with Third World populations, it is not currently possible to identify a valid threshold of arsenical effects in U.S. populations. These limitations include inadequate control for confounding factors, underestimated total exposure, and higher susceptibility due to poor nutrition [14].

Arsenic levels in many of the tap water samples substantially exceed the recently revised EPA drinking water standard for arsenic. On January 22, 2001, EPA adopted a new standard for

arsenic in drinking water, lowering it from 50 ppb to 10 ppb. Public water systems must comply with the 10 ppb standard beginning January 23, 2006 [16].

Tungsten

Tungsten was found in all tap water samples at levels ranging from 0.25 to 337 ppb. The highest levels were found in samples collected from residences whose drinking water source is a private well.

EPA has no MCL for tungsten and does not list the element in its IRIS databank. The health effects and levels of concern for tungsten in drinking water are not known. Most of the known adverse health effects of tungsten, such as irritation of the respiratory tract, are associated with inhalation exposures in industrial settings. The National Institute for Occupational Safety and Health (NIOSH) has established an exposure limit of 5 mg/m³ in air [17]. In experimental animals, large overdoses have produced central nervous system disturbances, diarrhea, respiratory failure, and death [18]. No evidence exists to suggest that tungsten, at the levels detected in Churchill County tap water, pose any hazard to human health. However, NCEH requested that the National Institute of Environmental Health Sciences (NIEHS) conduct toxicological studies for tungsten.

Uranium

Uranium was found in 74 of 77 tap water samples at levels ranging from 0.004 to 290 ppb. Nine of these results exceeded the 30 ppb EPA MCL for uranium. In general, the highest uranium levels were found at residences with private wells less than 50 feet deep.

Uranium is a naturally occurring radioactive element that is present in nearly all rocks and soils. Parts of the western United States have higher than average uranium levels because of natural geological formations. Natural uranium consists of isotopic mixtures of ²³⁴U, ²³⁵U, and ²³⁸U and enters groundwater through erosion of rock and soil. Although radiation exposure has been generally assumed to be carcinogenic at all dose levels, no correlation has been established at doses that occur from exposure to natural radiation [19]. As a result, the health effects associated with oral exposure to natural uranium appear to be solely chemical in nature and not radiologic. Toxicologic studies indicate that long-term exposures to uranium in drinking water at the highest levels found in Churchill County might pose an increased risk for kidney damage [19].

Vanadium

Vanadium was detected in 42 tap water samples at levels ranging from 10 to 430 ppb. Six of these levels exceeded the ATSDR intermediate EMEG of 30 ppb for children. Those six elevated levels were from samples collected at residences in which tap water comes from private wells. All samples collected from the public drinking water supply contained vanadium levels of 30 ppb or less.

The maximum concentration of vanadium (430 ppb) is not likely to pose a public health threat. The ATSDR MRL for vanadium (0.003 mg/kg/day) was derived from a NOAEL of 300 µg/kg/day for renal effects in rats and includes an uncertainty factor of 100 [20]. Another study suggests that the NOAEL in humans for renal effects could be more than four times higher than the rat NOAEL [21].

Volatile Organic Compounds (VOCs)

ATSDR compared levels of VOCs found in residential tap water with health-based CVs to identify potential contaminants of concern (COCs). Several VOCs were found at levels below the ATSDR screening values for drinking water, EPA MCLs, or EPA Region III Planning Remediation Guides. As a result, these substances were eliminated from the list of potential COCs. The other VOCs found in residential drinking water along with their measured levels and comparison values are shown in Table 2.

Table 2. Summary of Potential VOCs of Concern in Drinking Water

Substance	Number of Detections	Maximum Concentration (ppb)	Average Detected Level (ppb)	Comparison Value (ppb)
Bromoform*	27	16.5	5.01	4
Chlorodibromomethane*	26	1.9	0.988	0.4
1-Ethyl-2-Methylbenzene	1	0.84	0.84	NA
Benzene, 1,2,3,5-Tetramethyl Benzene	1	0.2	0.2	NA
Ethyl Tert-Butyl Ether	1	0.02	0.02	NA
Methyl-4-(1-Methylethyl)Benzene	1	0.02	0.02	NA

NA means "Not Available".

* One of four chemicals known as trihalomethanes (THMs)

Trihalomethanes

Bromoform and chlorodibromomethane are chemicals known as trihalomethanes (THMs). THMs are disinfection byproducts formed when chlorine or other disinfectants used to control microbial contaminants in drinking water react with naturally occurring organic and inorganic matter in water. The four THMs are chloroform, bromodichloromethane, dibromochloromethane, and bromoform. EPA set an MCL of 0.1 parts per million (0.1 ppm) for the combination of bromoform and chlorodibromomethane and other THMs that occur in chlorinated water. EPA has developed a new standard for total trihalomethanes (TTHM) at a maximum allowable annual average level of 80 ppb. This standard will become effective for the first time in December 2003 for small surface water and all ground water systems [22]. Even the maximum TTHM levels found in the tap water samples are well below the EPA standard [23].

Other VOCs

No screening values exist for four of the VOCs measured in tap water samples. These VOCs are 1-Ethyl-2-Methylbenzene; Benzene; 1,2,3,5-Tetramethyl Benzene; Ethyl Tert-Butyl Ether; and Methyl-4-(1-Methylethyl)Benzene. However, each of these compounds was detected in only one sample and at less than 1 ppb. As a result, these VOCs are not expected to be a public health concern.

Previous USGS Groundwater Sampling

During the summer of 2001, USGS sampled 100 public supply, domestic, and industrial wells in the Fallon area [R. Seiler, USGS, personal communication, 2003]. One of the main purposes of the sampling was to characterize the current water quality of all drinking water sources in the Fallon area. In addition, wells sampled by USGS in 1989 were re-sampled in order to determine whether changes in water quality had occurred since that time. These samples were analyzed for several constituents, including:

- metals;
- VOCs;
- pesticides;
- uranium isotopes;
- radon; and
- alpha, beta, gamma radioactivity [24].

USGS concluded that few samples contained VOCs or pesticides. All reported VOC concentrations in drinking water wells were less than ATSDR screening values. Substances associated with fuel (benzene, toluene, ethyl benzene, xylene, and polycyclic aromatic

hydrocarbons) were found in only one well at an industrial site. The quality of the water in the three aquifers used for drinking water has not changed since 1989. Arsenic, uranium, and radon in groundwater commonly exceed drinking water standards [24].

Children's Health Considerations

ATSDR recognizes that the unique vulnerabilities of infants and children require special emphasis in communities faced with environmental contamination. For this evaluation, ATSDR has taken into account that children could be exposed to environmental contaminants in tapwater.

Conclusions

ATSDR evaluated tap water data as part of its environmental pathway analysis for Churchill County.

- Because arsenic levels are of concern in municipal and private wells and because uranium levels are of concern in shallow private wells, ATSDR categorizes the Churchill County tap water as a public health hazard.
- Tap water is safe for bathing, showering, and laundry uses.

Recommendation

Restrict consumption of tap water in Churchill County as a primary drinking water source until the new water treatment plant is operational.

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Appendix

Table A. Potential Contaminants of Concern from 34 Tap Water Samples from Municipal Water Supply (2002)

Substance	Number of Detections	Minimum Concentration (ppb)	Maximum Concentration (ppb)	Mean Concentration (ppb)	Comparison Value (ppb)
Arsenic	32	2	102	74.8	0.02
Bromoform	26	0.07	16.5	5.2	4
Chlorodibromomethane	2	0.1	1.9	1.02	0.4
Sulfate	34	1	91.4	66.2	NA
Tungsten	34	0.25	27.2	19.1	NA
Vanadium	26	20	30	29.6	30

NA means “Not Available”.

Table B. Potential Contaminants of Concern from 18 Tap Water Samples Collected from Private Wells More than 50 Feet Deep (2002)

Substance	Number of Detections	Minimum Concentration (ppb)	Maximum Concentration (ppb)	Mean Concentration (ppb)	Comparison Value (ppb)
1,2,3-Trimethylbenzene	1	0.8	0.8	0.8	NA
1,2,4-Trimethylbenzene	2	1.6	3.19	1.6	NA
1,2,3,5-Tetramethyl Benzene	1	0.2	0.2	0.2	NA
1-Ethyl-2-Methylbenzene	1	0.84	0.84	0.84	NA
Arsenic	18	3	683	102	0.02
Ethyl Tert-Butyl Ether	1	0.02	0.02	0.02	NA
Methyl-4-(1-Methylethyl)Benzene	1	0.02	0.02	0.02	NA
N-Propyl Benzene	1	0.09	0.09	0.09	NA
Sulfate	18	0.1	169	45.5	NA
Tungsten	18	0.25	337	37.5	NA
Vanadium	4	20	170	75	30

NA means “Not Available”.

Table C. Potential Contaminants of Concern from 18 Tap Water Samples Collected from Private Wells Less than 50 Feet Deep (2002)

Substance	Number of Detections	Minimum Concentration (ppb)	Maximum Concentration (ppb)	Mean Concentration (ppb)	Comparison Value (ppb)
Antimony	6	0.9	6.3	2.5	4
Arsenic	17	5	874	96.9	0.02
Sulfate	18	0.9	529	118	NA
Tungsten	18	0.9	148	10.5	NA
Uranium	18	0.009	290	48.4	30
Vanadium	9	10	430	82.2	30

NA means “Not Available”.

Table D. Potential Contaminants of Concern from 6 Tap Water Samples Collected from Private Wells at Unspecified Depths (2002)

Substance	Number of Detections	Minimum Concentration (ppb)	Maximum Concentration (ppb)	Mean Concentration (ppb)	Comparison Value (ppb)
Arsenic	5	18	87	45.8	0.02
Sulfate	7	0.1	142	59.9	NA
Tungsten	7	0.25	7.07	2.37	NA
Uranium	6	0.015	0.015	0.015	30
Vanadium	3	10	40	26.7	30